Your thesaurus codes are:
08(09.16.2 A58 = NOVA AQL 1919; 09FIg.Fig.16.1; 04.19.1)

ASTROPHYSICS
June 20, 2000

# New identification of the near infrared Source in the "born-again" Planetary Nebula A58 (=V605 Aql) ⋆

**S. Kimeswenger, J. Koller, and S. Schmeja**

Institut für Astrophysik der Leopold-Franzens-Universität Innsbruck, Technikerstraße 25, A-6020 Innsbruck, AUSTRIA
http://astro.uibk.ac.at

Received 15 May 2000 / Accepted 6 June 2000

**Abstract.** The central dust knot (V605 Aql = Nova Aql 1919) in the planetary nebula A58 is the result of a late-helium flash. Previous near infrared (NIR) measurements yield very bright fluxes. This exceeds model predictions, based on other wavelengths and estimates of the visual extinction within the object, by a factor of 100. Using NIR imaging by the DENIS instrument, we found that the source was misidentified in previous (single channel photometer) observations. We present the NIR flux of A58 and identify the stellar field source, which is in fact associated with the NIR source given upt to now in the literature. The new identification is consistent with model predictions for the source. An accurate astrometry for the core of A58 is also provided.

**Key words:** (ISM) planetary nebulae: general - planetary nebulae (individual: A58 = V605 Aql = Nova Aql 1919) - surveys

## 1. Introduction

The central star of the planetary nebula A58 underwent in 1919 the rare event of a very late helium flash ("born-again" scenario; Iben et al. 1983; Iben 1984). For a review of the object see Manchado (1996) and Clayton & de Marco (1997). It is only one out of two such events during the timescale of modern astronomy (the second event was Sakurai's Nova in 1996; Dürbeck & Benetti 1996) Those objects undergo strong phases of dust condensation (Kimeswenger et al. 1997). Thus, several infrared measuring campaigns focused on this object. While the mid infrared domain was observed with the imaging devices of the ISO satellite (Kimeswenger et al. 1998a), in the near infrared (NIR) only single channel aperture photometry was available (Harrison 1996; van der Veen et al. 1989). They give J = 10.25, H = 9.32, K = 9.05 and J = 10.32, H = 9.32, K = 9.10 respectively. However, their measurement suffer from low angular resolution and pointing accuracy of the telescopes. Van der Veen et al. provide (Table 5 therein) typical errors of 15″-20″ and maximum errors up to 40″ for the positional deviation between their NIR source and the IRAS source. Even if they interpret this mainly as an error caused by IRAS, it contains also a significant contribution from the NIR position. Modelling the complete spectral energy distribution of this object (Koller & Kimeswenger 1999, 2000a, 2000b), the near infrared excess was typically a factor of 100. This is consistent with models of similar objects like V4334 Sgr (= Sakurai, Kerber et al. 1999). While Harrison (1996) tried to describe this excess by a second component of extremely hot dust, Kimeswenger et al. (1998a) tried to explain it as the hot central star obscured by several magnitudes of extinction (Seitter 1987). The latter model did not hold, as the luminosity for such an object exceeds by far the complete measured bolometric luminosity. To solve this problem, we obtained images at 0.8$\mu$m, 1.2$\mu$m and 2.15$\mu$m using the DENIS instrument (Epchtein et al. 1994, 1997) to investigate the exact location of the NIR emission. We were able to find the real flux associated with this source and to identified the NIR source misinterpreted as V605 Aql by Harrison (1996) and van der Veen et al. (1989).

## 2. Results and Discussion

The data were obtained using the DENIS survey instrument at the ESO 1m telescope (Epchtein et al. 1997, Kimeswenger et al. 1998b) on May 7$^{th}$, 2000 8:15 UT. The images were taken simultaneously in all three bands, Gunn-I (0.82$\mu$m), J (1.2$\mu$m) and Ks (2.15$\mu$m). Each band was observed with five images while moving around the source in the field of view. This was used to eliminate errors due to local flatfield effects and to be able to obtain the sky background using the iso-airmass median sky filtering. Thie procedure provides also an estimate of the intrinsic error of the measurement, being better than 0.03 mag. The flux calibration was done individually using all standards of the night. We did not use the extinction correction applied for the DENIS survey (Epchtein et al 1999;

*Send offprint requests to*: S. Kimeswenger
Stefan.Kimeswenger@uibk.ac.at

⋆ Based on observations collected at the European Southern Observatory, La Silla, Chile at the DENIS consortium survey instrument

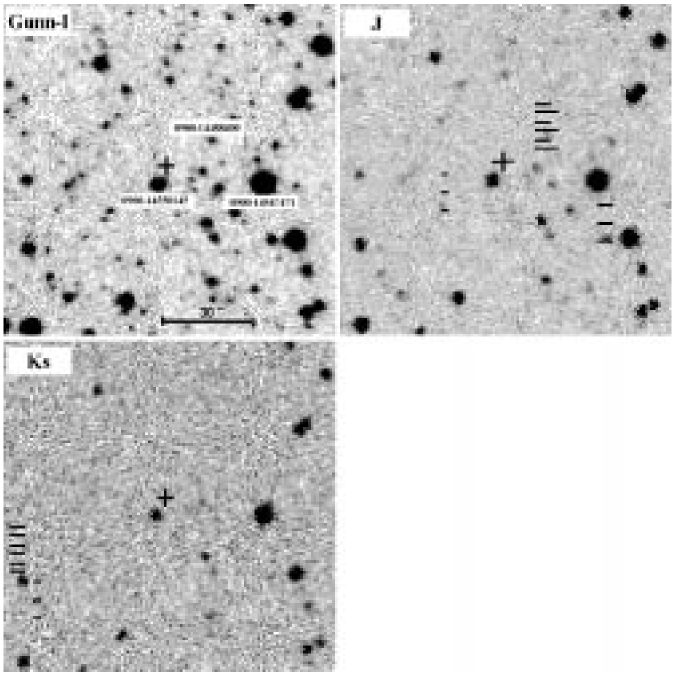


**Fig. 1.** The DENIS NIR images of the region arround A58 (V605 Aql). The position of the (weak) source is indicated by a fine lined cross in all three bands. The numbers indicate the USNO A2 star numbers of the astrometric reference frame used. The sets of horizontal black lines in the NIR images are detector defects.

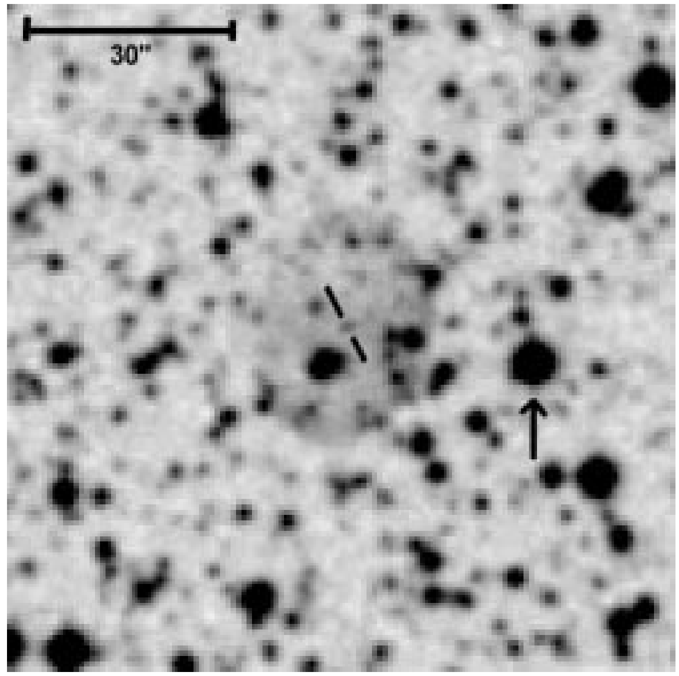


**Fig. 2.** The red DSS2 image of the region arround A58 (V605 Aql). The position of the "born-again" core of A58 is indicated near the center. The arrow marks the star USNO A2 0900-14547471, which is most likely the NIR source measured by Harrison (1996) and van der Veen et al. (1989).

Fouque et al. 2000) but derived it individually for all three bands. Figure 1 shows the first images of the sequence in all bands. The optical identification was done using the digital sky survey (Figure 2) and the plate presented by Pollacco et al. (1992). The near infrared flux for V605 Aql (position marked by a cross) can be given only as upper limits (J < 15.8, Ks < 13.5). In the red visual band (Gunn-I) it is just detected near the limit ($\approx$ 18.0$\pm$0.25).

The astrometry was obtained using both, the red Digital Sky Survey 2 image (DSS2) and the DENIS images. The stars USNO A2 0900-14547471, 0900-14550145 and 0900-14488400 were used as reference and the next nearby TYCHO2 sources (about $3'$ distance) were used as a control frame to estimate the USNO A2 errors in that region. There is an weak indication for a systematic shift (using the next nearby TYCHO stars USNO A2 0900-14571943, 0900-14569482, 0900-14571215, 0900-14529771 and 0900-14582492) of $\Delta\alpha$ = -0.24$''$, $\Delta\delta$ = 0.15$''$. As the rms noise is about 0.40$''$, we did not apply this shift to the resulting coordinates.

Although star 0900-14550145 has the smallest distance to the core of A58, it is not usable for precise cooridnates. There are clearly two weak stars blended on the DSS2. Thus, the coordinates for A58 were obtained using the two other nearby stars mentioned above only. The coordinates then were measured both, on the DENIS frames and on the DSS2, independently. The accuracy (rms) is better than 0.5$''$ relative to the USNO A2 reference frame.

$$\alpha_{A58} = 19^h18^m20\overset{s}{.}42 \quad \text{(J2000)}$$
$$\delta_{A58} = 01^\circ47'01\overset{''}{.}1 \quad \text{(J2000)}$$

The star marked in Figure 2 by the arrow 34.9$''$ right from the nebula core is USNO A2 0900-14547471 and has a brightnes of Gunn-I = 11.73, J = 10.19, Ks = 9.08. As there is no other source as bright and having a similar color (J-K = 1.11), it is most likely the source measured by Harrison (1996; J = 10.25, K = 9.05) and van der Veen et al. (1989; J = 10.32, K = 9.10). Also the distance provided by van der Veen et al. supports this result.

Using the model in Koller & Kimeswenger (2000b) we predict Gunn-I = 16.9 , J = 15.0, Ks = 13.0. Although this is a little bit brighter than the measured flux, it is well consistent with the magnitudes/limits given above. The models show that at those NIR wavelengths already $\approx$70$-$80% of the radiation originates from the gas component. The input parameters for the gas are still very uncertain due to the lack of good optical spectra. are uncertain concerning the gas free-free emission, contributing already up to 80 % in those wavelengths.

*Acknowledgements.* This project was supported by the Austrian FWF project P11675-AST. We thank the DENIS consortium (PI N. Epchtein, Nice, F) for beeing able to do these additional observations. The DENIS project is partly funded by the European Commission grants. It is also supported, in France by the INSU, CNRS, Germany by the State of Baden-Würtemberg, in Spain by the DGICYT, in Italy by the CNR, in Austria by the Fonds zur Förderung der wissenschaftlichen Forschung und Bundesministerium für Wissenschaft und Forschung, in Brazil by the FAPESP, and in Hungary by an OTKA grant and an ESO C & EE grant.

## References

Clayton G.C., deMarco O. 1997, AJ 114, 2679
Dürbeck H.W., Benetti S. 1996, ApJ 468, L111
Epchtein N., de Batz B., Copet E., et al. 1994, Ap&SS 217, 3
Epchtein N., de Batz B., Capoani L., et al. 1997, The ESO Messenger 87, 27
Epchtein N., Deul E., Derriere S., et al. 1999, A&A 349, 296
Fouque P., Chevallier L., Cohen M., et al. 2000, A&AS 141, 313
Harrison T.E., 1996, PASP 108, 1112
Iben I., 1984, ApJ 277, 333
Iben I., Kaler J.B., Truran J.W., Renzini R. 1983, ApJ 264, 605
Kerber F., Blommaert J.A.D.L., Groenewegen M.A.T., et al. 1999, A&A 350, L27
Kimeswenger S., Gratl H., Kerber F., et al. 1997, IAUC 6608
Kimeswenger S., Kerber F., Weinberger R. 1998a, MNRAS 296, 614
Kimeswenger S., Kerber F., Roth M., et al. 1998b, A&A 332, 300
Koller J., Kimeswenger S. 1999, in Workshop on Thermal Emission Spectroscopy and Analysis of Dust, Disks, and Regoliths. LPI Contribution No. 969, Lunar and Planetary Insitute, p. 15
Koller J., Kimeswenger S. 2000, ASPConf. Ser. 196, 23
Koller J., Kimeswenger S. 2000, Ap&SS, in press
Manchado G. 1996, ApJ 472, 711
Pollacco D.L., Lawson W.A., Clegg R.E.S., Hill P.W. 1992, MNRAS 257, 33p
Seitter W.C. 1987, The ESO Messenger 50, 14
van der Veen W.E.C.J., Habing H.J., Geballe T.R. 1989, A&A 226, 108